APPENDIX B

ORR BIOSOLIDS LAND APPLICATION PROGRAM AND WETF CHARACTERIZATION DATA

B.1 CITY OF OAK RIDGE BIOSOLIDS CHARACTERISTICS

This section discusses the characterization of the biosolids from the city of Oak Ridge POTW, which are currently being land applied on the ORR. Biosolids characteristics discussed include constituent inorganic chemicals, heavy metals, organic chemicals, radionuclides, and pathogens as they relate to biosolids Classes A and B.

Inorganic Chemicals

Biosolids inorganic analytical parameters must be sampled annually, as stated in the NPDES (TDEC 1998) and EPA (EPA 1997) permits issued to the City of Oak Ridge. The city performs these analyses depending upon the EPA and TDEC required frequencies. ***Table B.1*** shows the minimum, mean, and maximum levels of each required analyte found in the city's biosolids from 1993 to 2000 (City of Oak Ridge 1994-2000).

Table B.1. Inorganic Parameters and Analytical levels in City of Oak Ridge Biosolids (1993-2000)

Analyte	Sampling frequency	1993 levels (mg/kg dry wt)	1994 levels (mg/kg dry wt)	1995 levels (mg/kg dry wt)	1996 levels (mg/kg dry wt)	1997 levels (mg/kg dry wt)	1998 levels (mg/kg dry wt)	1999 levels (mg/kg dry wt)	2000 levels (mg/kg dry wt)
		Max	Max	Max	Max	Max	Max	Max	Max
Ammonia-nitrogen[a]	3/Year	20300	30000	34,900	28672	43000	33000	41000	33000
Manganese	3/Year	1,260	1,710	1,540	1345	1900	1400	1100	880
Nitrate *nitrogen*	3/Year	8.5	269.0	144.0	250	220	920	1000	380
Nitrite Nitrogen[a]	3/Year	6.5	30.7	30.7	N/A	N/A	N/A	N/A	N/A
Organic nitrogen	3/Year	31,000	49,800	66,000	64400	48000	52000	62000	92000
pH	Daily	7.1	8.1	7.5	8	8	8.4	7.9	7.2
Potassium	3/Year	3,420	5,410	6,020	5510	7100	4600	6000	3500
Phosphorus	3/Year	25,400	36,800	36,800	31800	48000	32000	47000	35000
Total Kjeldahl Nitrogen[b]	3/Year	59,200	77,200	89,100	89100	120000	87000	97000	93000
Total Nitrogen[b]	3/Year	61,616	77,223	89,127	89127	120140	87190	98000	93300
Total solids %	Daily	2.0	3.3	3.3	3.9	3.6	3.2	3.2	3
Volatile solids (% of TS)	Daily	61%	62%	63%	63%	63%	64%	63%	64%

Source: City of Oak Ridge 1994, 1995, 1996, 1997, 1998, 1999 and 2000

[a] These parameters are required to be sampled annually by NPDES permit #TN0024155. Reporting of quantitative data is required, but limits are not specified.

[b] Total nitrogen represents the sum of total Kjeldahl and nitrate nitrogen.

Heavy Metals

Heavy metal sampling and analysis is based upon the total amount of biosolids produced within a calendar year. The City of Oak Ridge averages 400 dry tons per year which places their operation in the 290 to 1,500 tons per year EPA designation, requiring quarterly analysis for the (9) regulated metals listed in 40 CFR 503.13. With the exception of the Y-12 sewer mercury incident in 1995 that resulted in the inadvertent discharge of mercury producing city biosolids in excess of established 40 CFR 503 limits during video surveillance of the Y-12 sewer system, the concentrations of heavy metals have been well below the 40 *CFR* 503.13 ceiling concentration limits. ***Table B.2*** compares maximum concentration of each heavy metal in Oak Ridge POTW biosolids with the ceiling concentration limits for that metal. Although quarterly sampling and analysis is required for these metals, monthly analysis is performed by an EPA-certified, commercial laboratory. The additional monitoring is designed to help prevent an abnormally high concentration of a heavy metal from being applied on the ORR and to prevent total loading limits from being exceeded.

Organic Chemicals

The City of Oak Ridge's NPDES permit requires annual sampling of biosolids organic analytical parameters. Currently, the city performs these analyses, including other organic compounds not required to be tested such as benzene, toluene, etc. ***Table B.3*** summarizes the maximum levels of organics in the biosolids from 1993 to 2000. Most of the organic chemicals were undetected.

Radionuclides

Both the biosolids and the land application areas on the ORR are part of an ongoing radiological monitoring program (see ***Section 6.0*** for a summary of permit and regulatory requirements). Because of the various contributions of natural background radiation, atmospheric deposition, industrial operations, and medical facilities, all biosolids contain radioactive materials.

Bulk gamma emitters and selected radionuclides (e.g., cobalt-60, cesium-137, iodine-131) are monitored by the Oak Ridge POTW daily during application, analyzed quarterly using composite biosolids samples, and monitored on an as-needed basis in land application area soils. The City of Oak Ridge collects the soil samples and contracts with ORNL to analyze the samples for radionuclide content.

In 1984, there was a report of elevated levels of Cobalt-60 in the biosolids from the Oak Ridge POTW; however, no cleanup was necessary at the treatment plant because of the relatively low concentrations and short half lives (i.e., < 5 years) of the radionuclides (DOE 1996). It was determined that land-applied biosolids contained elevated levels of Cobalt-60 from a private manufacturing facility in Oak Ridge. Because of the relatively short half-life of Cobalt-60 (5.3 years), the levels were determined to be of minimal risk. However, as a precaution the land application site (McCoy) was closed, and an extensive sampling and monitoring program was developed to ensure that no biosolids with radioactivity in excess of prescribed action levels outlined in the Oak Ridge POTW Gamma Screening Protocol (City of Oak Ridge 1999) would be applied without additional sample screening by ORNL. Low-level radiation surveys were conducted at the McCoy site in September 1994, and active and retired biosolids application sites were also surveyed. Radiation above background levels was not detected (DOE 1996).

Table B.4 shows the average radiological characterization of the Oak Ridge biosolids from 1996 to 2000.

Major contributors to the radiological content of the City of Oak Ridge POTW biosolids include groundwater infiltration containing naturally-occurring radionuclides (Radium, Uranium, Potassium-40, Beryllium-7), medical facilities (Iodine-131, Technetium-99m), industrial facilities (Cobalt-60 and Cesium-137), ORNL biosolids (Strontium-90 and Cesium-137) and the Y-12 Plant (Uranium). As expected, the levels of naturally occurring radionuclides in the biosolids remain relatively constant. The contribution of radionuclides from industrial facilities (including the Y-12 Plant) has shown an overall reduction and remain well under established 4 mrem/yr RESRAD planning levels. For example, the uranium content of biosolids dropped from 1.57 pCi/g to non-detectable levels between 1996 and 2000, most likely due to sewer line rehabilitation projects on both the City of Oak Ridge and Y-12 sewer systems.

Pathogens

The pathogen reduction requirements for biosolids are divided into two categories: Class A and Class B. If the biosolids meet Class A, pathogen levels are reduced to levels below detection limits. If the biosolids meet Class B, the pathogen levels are reduced to levels that are unlikely to threaten public health and the environment when applied to land with specific use restrictions. The 40 CFR 503 site restrictions (e.g., no application in frozen or flooded areas, wetlands, threatened or endangered species or designated habitats, etc.) for application of Class B biosolids minimize the potential for human and domestic animal contact until environmental attenuation has further reduced the pathogen levels. Biosolids that are applied to home gardens or distributed to the public must meet Class A pathogen requirements. Biosolids that are applied in bulk form to agricultural land, forest, reclamation sites, or public sites must meet either Class A or Class B pathogen requirements.

The City of Oak Ridge POTW biosolids currently meet Class B standards and will meet Class A standards after their biosolids process modification in the Summer of 2001. Even though the City of Oak Ridge would meet Class A standards which would allow the biosolids material produced at the POTW to be freely distributed to the community, the City of Oak Ridge plans to continue to utilize the existing land application sites for the beneficial re-use of all of the material produced because of the long history of program operations and DOE cooperation.

Either liquid or solid biosolids that meets either Class A or Class B standards may be land applied on the ORR. The City of Oak Ridge POTW is currently producing and applying liquid Class B biosolids. However, the city will be producing only Class A biosolids material beginning in the Summer of 2001. Whether biosolids are applied in liquid or solid form, existing program limits for heavy metals, nitrogen and radionuclides are all calculated on a dry weight basis (i.e., 100% solids). For this reason, all analytical results, calculations for risk assessment and RESRAD modeling involving biosolids will be done on a dry weight basis and will cover both liquid or solid materials. Class B liquid may be applied only in areas evaluated by TDEC and permitted by EPA. Solid Class A biosolids may be land applied without permit restrictions per 40 CFR 503.

Table B.2. Concentrations of Heavy Metal Levels in City of Oak Ridge Biosolids (1993-2000) versus 40 CFR 503.13 Limits

Heavy Metal	40 CFR 503.13 Limits	1993 (mg/kg)		1994 (mg/kg)		1995 (mg/kg)		1996 (mg/kg)		1997 (mg/kg)		1998 (mg/kg)		1999 (mg/kg)		2000 (mg/kg)	
		Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Arsenic	75	5.9	25.1	4.2	9.1	9.03	9.12	6.71	12.8	2.5	7.5	2.4	4.3	2.7	4.7	2.1	3.8
Cadmium	85	10.4	15.1	9.4	17.8	8.3	11	9.92	19.4	3.6	5.2	3.1	4.8	3.4	3.8	3.1	4.5
Copper	840	460.1	544	450.6	490	476.5	543	361.7	520	430.8	570	479.2	700	484.4	570	510.8	620
Lead	4300	69.3	88.4	103.6	128	71.2	116	32.52	74	38	74.6	33.6	63	36.6	43	36.2	48
Mercury	57	9.12	16.2	7.59	9.45	57.6[a]	264[a]	2.16	8.2	12	20	11	16	10.6	19	6	11
Molybdenum	75	27.8	33.8	19.73	23.5	17.7	26.6	23	54	7	13	10.1	21	15.8	21	13.9	26
Nickel	420	40.2	51	37.6	45.6	35.8	61.5	26.23	39.7	28.2	42	33.5	100	25.5	47	63.1	100
Selenium	100	7.6	20.9	5.7	10.2	6.5	15.1	10.29	18.2	1.7	3.1	3.1	7	8.6	14	8.4	15
Zinc	7500	1698	2070	1700	1840	1641	1940	887	1610	1404	1910	1209	1600	1150	1400	1039	1600

Source: City of Oak Ridge 1994 - 2000

[a] Biosolids that exhibit mercury levels of 40 CFR 503.13 limits were disposed at a landfill under a special waste permit from TDEC

Table B.3. NPDES Organic Parameters and Concentrations of Organic Constituents in City of Oak Ridge Biosolids (1993-2000)

Analyte	Sampling frequency	1993 levels (mg/kg dry wt)	1994 levels (mg/kg dry wt)	1995 levels (mg/kg dry wt)	1996 levels (mg/kg dry wt)	1997 levels (mg/kg dry wt)	1998 levels (mg/kg dry wt)	1999 levels (mg/kg dry wt)	2000 levels (mg/kg dry wt)
		Max	Max	Max	Max	Max	Max	Max	Max
Aldrin	Annually	U	1.1	0.021	0.025	U	U	0.38	0.67
Chlordane	Annually	0.55	U	0.33	2.7	1.3	0.34	3.8	6.7
DDD	Annually	U	U	U	U	0.071	U	0.38	0.67
DDE	Annually	U	0.05	U	0.01	0.023	U	0.38	0.67
DDT	Annually	U	U	U	U	0.0071	U	0.38	0.67
Dieldrin	Annually	U	0.07	0.09	0.099	0.061	U	0.38	0.67
Heptachlor	Annually	U	U	U	U	U	U	0.38	0.67
Lindane (gamma-BHC)	Annually	U	U	.0075	U	U	U	0.38	0.67
PCBs	Annually	U	0.96	0.37	U	U	U	7.7	N/A
Toxaphene	Annually	U	U	U	U	U	U	7.7	13
Trichloroethene	Annually	U	U	U	U	U	U	0.038	0.17
Benzo(a)pyrene	Annually	U	U	U	U	1	U	13	11
Dimethylnitrosamine (n-nitroso-di-methylamine)	Annually	U	U	U	U	U	U	13	11
Hexachlorobenzene	Annually	U	U	U	U	U	U	13	11
Hexachlorobutadiene	Annually	U	U	U	U	U	U	13	11

Source: City of Oak Ridge 1994 through 2000

U = Undetected. Indicates that the compound was analyzed for but was not detected.

Table B.4. Concentrations of Radionuclide Levels in City of Oak Ridge Biosolids (1996-2000)

Radionuclide	4 mrem/yr Biosolids Planning level (pCi/g)	1996 (pCi/g)		1997 (pCi/g)		1998 (pCi/g)		1999 (pCi/g)		2000 (pCi/g)	
		Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
Cobalt-60	10.7	0.46	7.05	0.51	8.96	0.52	1.17	0.51	0.8	0.48	0.81
Cesium-137	43.6	0.8	9.24	0.31	0.85	0.36	0.69	2.07	4.17	1.88	3.8
Iodine-131	N/A	35.7	103	21.6	86.2	9.46	32.6	8.52	44.8	5.7	40.1
Beryllium-7	N/A	2.72	5.05	1.7	6.15	1.3	2.69	1.08	1.89	0.72	1.09
Potassium-40	120	7.19	12.3	6.19	8.08	6.04	9.27	5.86	7.24	5.67	10.43
Radium-228	20.7	1.13	1.69	1.01	1.42	0.97	1.51	0.84	1.36	0.62	0.99
Uranium-235	157	0.75	1.85	0.35	0.71	0.33	0.83	0.36	0.73	N/D	N/D
Uranium-238	459.5	13.3	51	8	24.2	10.6	21.9	7.62	15.7	2.58	6.2

Source: City of Oak Ridge 1996 - 2000

Class B biosolids are well suited for land application on the ORR because the existing access restrictions are consistent with site restrictions for bulk biosolids land application. Class A biosolids have fewer restrictions regarding how and where it can be applied, but result in higher treatment costs to meet Class A standards.

B.2 OAK RIDGE RESERVATION LAND APPLICATION SITE CHARACTERISTICS

This section discusses the six ORR sites currently utilized for biosolids application by the City of Oak Ridge. Site profile sheets are available in ***Tables B.5*** through ***B.10*** that provide cumulative nitrogen, heavy metal and radionuclide loading levels as of December 31, 2000 as well as relevant NEPA characteristics such as threatened and endangered species, wetlands, etc.

Inorganic Chemicals

Biosolids land application site soils are required by TDEC to be analyzed for a number of inorganic parameters once every 3 years. Until recently, the City of Oak Ridge performed soil analyses annually to establish a thorough baseline of data.

Soil sampling frequency for land application sites is now performed every 2 years. ***Table B.11*** summarizes soil sample results collected during various times in the program history and compares them to data collected in reference areas that have not received biosolids application. Results are reported in the annual biosolids management report that is prepared February 19, annually.

Two limits are in effect for nitrogen loading on ORR land application sites, annual and lifetime loading limits. Annual limits are based upon EPA requirements to calculate the nitrogen (i.e., agronomic) loading limit. The annual nitrogen limit takes into account previous applications of biosolids, nitrogen compound levels analyzed in the biosolids and the vegetation nitrogen growth needs found on the application site. A calculation, known as plant available nitrogen (PAN) is performed to determine annual vegetation nitrogen needs. The calculation is as follows:

Plant Available Nitrogen = (MR)(Organic Nitrogen) + (VR)(Ammonia Nitrogen) + Nitrate Nitrogen

MR - mineralization rate, rate at which organic nitrogen is released as readily available nitrogen
VR - volatilization rate, rate at which ammonia nitrogen is released directly to atmosphere without being utilized by plants

This calculation is adjusted as new nitrogen analyses are performed as well as the total quantity of biosolids land applied within a calendar year are recorded. By using this methodology, all available nitrogen is utilized by plant to sustain growth on the application site in question, eliminating nitrogen as a groundwater contaminant threat.

ORR land application sites also have a maximum lifetime loading limit of 50 tons/acre (dry wt.) imposed by TDEC and DOE. TDEC issued the LAA in 1989 before the 503 regulations were promulgated in 1993. Because the State of Tennessee has not receive the authority to administer and regulate biosolids land application sites, EPA issues land application permits directly to POTW performing land application operations in Tennessee. However, the State of Tennessee must approve the use of new land application sites prior to the EPA permit process. The calculated average life remaining for all of the six active application sites is approximately 7 years.

Heavy Metals

EPA does not require soil sampling on sites that receive biosolids application; however, the city is required to track cumulative levels of the 9 heavy metals listed in 40 CFR 503.13, Table 2. Upon achieving 90% of the cumulative loading limit for any of the metals listed, formal notification to EPA is required. As of December 31, 2000 the maximum level reached for any metal on any site was 6% of the EPA limits, which was for mercury on the Rogers Site.

Organic Chemicals

The City of Oak Ridge's EPA land application permit does not require organic chemical analysis for site soils; however, organic compound analysis was performed on sites as a conservative measure. ***Table B.11*** summarizes the maximum levels of organics found in site soils in 1993. Most of the organic chemicals were undetected.

Radionuclides

There are no federal requirements to test land application site soils for radionuclides or federal limits on the radiological content of biosolids that are land-applied. Because of the various sources of natural background radiation and atmospheric deposition all soils contain some level of radioactive materials. The City of Oak Ridge collects the soil samples every 2 years and contracts with ORNL to analyze the samples for radionuclide content. Soil samples from adjacent areas that have not receive biosolids application are also collected and analyzed for comparative purposes in ***Table B.11***. All results are reported to EPA and TDEC in the Annual Biosolids Management Report submitted February 19, annually. Application site soil radionuclide results are very close and in some instances, less than results collected in non-applied areas.

Table B.5. Upper Hayfield #1 Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Upper Hayfield #1
Total Acres (ac):	30
Total Hectares (ha):	12.15
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	2 Ponds, 1 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.21	41	**0.5%**	Total Tons Allowed Lifetime:	1500
Cadmium	0.38	39	**1.0%**	Total Tons Applied to Date:	618
Chromium	6.84	-	**-**	Total Tons Remaining:	882
Copper	25.22	1500	**1.7%**	Total Tons per Acre Applied:	20.6
Lead	4.25	300	**1.4%**	Total Tons per Acre Remaining:	29.4
Mercury	0.62	17	**3.7%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.99	-	**-**		
Nickel	2.04	420	**0.5%**		
Selenium	0.33	100	**0.3%**		
Zinc	84.44	2800	**3.0%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.005	7.2	**0.001**	
Uranium-238	0.2	21.1	**0.009**	
Cesium-137	0.016	2	**0.008**	
Cobalt-60	0.017	0.49	**0.035**	
Sum of Fractions (limit is 1):			**0.053**	

Table B.6. Upper Hayfield #2 Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Upper Hayfield #2
Total Acres (ac):	27
Total Hectares (ha):	10.93
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	2 Ponds, 0.75 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.25	41	**0.6%**	Total Tons Allowed Lifetime:	1350
Cadmium	0.44	39	**1.1%**	Total Tons Applied to Date:	585
Chromium	7.59	-	**-**	Total Tons Remaining:	765
Copper	28.76	1500	**1.9%**	Total Tons per Acre Applied:	21.6
Lead	4.42	300	**1.5%**	Total Tons per Acre Remaining:	28.3
Mercury	0.71	17	**4.2%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.48	-	**-**		
Nickel	1.63	420	**0.4%**		
Selenium	1.92	100	**1.9%**		
Zinc	95.74	2800	**3.4%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.005	7.2	**0.001**	
Uranium-238	0.164	21.1	**0.008**	
Cesium-137	0.018	2	**0.009**	
Cobalt-60	0.016	0.49	**0.033**	
Sum of Fractions (limit is 1):			**0.051**	

Table B.7. High Pasture Site Profile Information

General Site Environmental Information	
Land Application Site Name:	High Pasture
Total Acres (ac):	46
Total Hectares (ha):	18.62
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	1 Pond, 0.3 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.26	41	**0.6%**	Total Tons Allowed Lifetime:	2300
Cadmium	0.44	39	**1.1%**	Total Tons Applied to Date:	560
Chromium	6.45	-	**-**	Total Tons Remaining:	1740
Copper	24.21	1500	**1.6%**	Total Tons per Acre Applied:	12.2
Lead	3.55	300	**1.2%**	Total Tons per Acre Remaining:	37.8
Mercury	0.51	17	**3.0%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.44	-	**-**		
Nickel	1.35	420	**0.3%**		
Selenium	1.75	100	**1.8%**		
Zinc	79.81	2800	**2.9%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.003	7.2	**0**	
Uranium-238	0.081	21.1	**0.004**	
Cesium-137	0.011	2	**0.006**	
Cobalt-60	0.012	0.49	**0.024**	
Sum of Fractions (limit is 1):			**0.034**	

Table B.8. Rogers Site Profile Information

General Site Environmental Information					
Land Application Site Name:	Rogers Site				
Total Acres (ac):	32				
Total Hectares (ha):	12.96				
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)				
Soil Density:	1.6 g/cm^3				
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site				
Designated Wetlands on Site:	1 Pond, 0.9 ac				
Archeological/State Historical Areas on Site:	None				
Predominant Vegetation:	Orchard grass				
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha				
Calculated Site Chemical Loading Levels					
Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.25	41	**0.6%**	Total Tons Allowed Lifetime:	1600
Cadmium	0.58	39	**1.5%**	Total Tons Applied to Date:	969
Chromium	18.02	-	**-**	Total Tons Remaining:	631
Copper	43.69	1500	**2.9%**	Total Tons per Acre Applied:	30.3
Lead	10.4	300	**3.5%**	Total Tons per Acre Remaining:	19.7
Mercury	1.1	17	**6.5%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	3.15	-	**-**		
Nickel	5.06	420	**1.2%**		
Selenium	0.44	100	**0.4%**		
Zinc	129.04	2800	**4.6%**		
Calculated Site Radiological Loading Levels					
Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels	
Uranium-235	0.002	7.2	**0**		
Uranium-238	1.599	21.1	**0.076**		
Cesium-137	0.033	2	**0.016**		
Cobalt-60	0.116	0.49	**0.237**		
Sum of Fractions (limit is 1):			**0.329**		

Table B.9. Watson Road Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Watson Road
Total Acres (ac):	117
Total Hectares (ha):	47.37
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	None
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Hardwoods & Orchard grass
Vegetation Nitrogen Growth Requirement:	120.67 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.26	41	**0.6%**	Total Tons Allowed Lifetime:	5850
Cadmium	0.46	39	**1.2%**	Total Tons Applied to Date:	1100
Chromium	7.04	-	**-**	Total Tons Remaining:	4750
Copper	25.33	1500	**1.7%**	Total Tons per Acre Applied:	9.4
Lead	4.12	300	**1.4%**	Total Tons per Acre Remaining:	40.6
Mercury	0.5	17	**3.0%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.44	-	**-**		
Nickel	1.55	420	**0.4%**		
Selenium	1.94	100	**1.9%**		
Zinc	84.06	2800	**3.0%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.002	7.2	**0**	
Uranium-238	0.064	21.1	**0.003**	
Cesium-137	0.009	2	**0.004**	
Cobalt-60	0.007	0.49	**0.014**	
Sum of Fractions (limit is 1):			**0.021**	

Table B.10. Scarboro Road Site Profile Information

General Site Environmental Information	
Land Application Site Name:	Scarboro Road
Total Acres (ac):	77
Total Hectares (ha):	31.17
Soil Type:	Fullerton Associations (Reddish Brown, silty, residual clays w/ cert fragments)
Soil Density:	1.6 g/cm^3
Threatened & Endangered Plant and Animal Species/Habitat Present on Site:	No plant or animal species found on this site
Designated Wetlands on Site:	6 Ponds, 1.54 ac
Archeological/State Historical Areas on Site:	None
Predominant Vegetation:	Orchard grass
Vegetation Nitrogen Growth Requirement:	236.32 kg/ha

Calculated Site Chemical Loading Levels

Parameter	Calculated Level as of 12/31/00 (kg/ha)	40 CFR 503, Table 2 Limit (kg/ha)	% Limit	**Nitrogen**	
Arsenic	0.23	41	**0.6%**	Total Tons Allowed Lifetime:	3850
Cadmium	0.41	39	**1.1%**	Total Tons Applied to Date:	1157
Chromium	6.63	-	**-**	Total Tons Remaining:	2693
Copper	24.35	1500	**1.6%**	Total Tons per Acre Applied:	15
Lead	3.56	300	**1.2%**	Total Tons per Acre Remaining:	35
Mercury	0.62	17	**3.6%**	Notes: Heavy metal and nitrogen loading are well below established TDEC and EPA regulatory limits	
Molybdenum	0.61	-	**-**		
Nickel	1.39	420	**0.3%**		
Selenium	1.72	100	**1.7%**		
Zinc	82.85	2800	**3.0%**		

Calculated Site Radiological Loading Levels

Radionuclide	Calculated Level as of 12/31/00	RESRAD 4 mrem/yr Planning levels	Fraction of Planning level	Notes: Radionuclide loading levels are well below established 4 mrem/yr dose rate RESRAD planning levels
Uranium-235	0.004	7.2	**0.001**	
Uranium-238	0.111	21.1	**0.005**	
Cesium-137	0.012	2	**0.006**	
Cobalt-60	0.009	0.49	**0.018**	
Sum of Fractions (limit is 1):			**0.03**	

Table B.11. Biosolids Land Application Site Soil Analyses

Parameter	Upper Hayfield #1		Upper Hayfield #2		High Pasture		Rogers Site		Watson Road		Scarboro Road	
	App.	Ref.	App.	Ref.	App.	Ref.	App.	Ref.	App.	Ref.	App.	Ref.
Inorganics (mg/kg unless otherwise noted)												
CEC (meq/100 g)	280	200	310	200	200	180	220	240	260	240	250	200
Manganese	510	1300	2600	1300	1200	260	790	1600	2000	1300	1400	1300
pH	4.3	5.3	5.7	5.3	5.9	5.7	6.8	5.7	6	8.5	8.1	5.3
Phosphorus	46	61	23	61	19	12	89	58	17	6	2.1	61
Potassium	330	370	520	370	280	260	1200	1100	760	900	590	370
Total Kjeldahl Nitrogen	430	470	520	470	300	350	100	100	290	220	83	470
Heavy Metals (mg/kg)												
Arsenic	2.2	2.7	2.2	2.7	1.7	1.5	N/A	N/A	0.057	2.1	2.5	2.7
Cadmium	0.61	0.48	0.69	0.48	0.52	0.32	0.74	0.56	0.11	0.49	0.71	0.48
Chromium	21	23	18	23	15	7.5	23	11	0.11	13	13	23
Copper	40	13	26	13	13	0.63	20	4.6	0.57	5.5	3.1	13
Lead	15	14	27	14	17	8.6	20	27	0.28	20	21	14
Nickel	4.8	5	5.8	5	5.3	3.2	6.3	6.4	0.57	11	3.6	5
Zinc	110	83	120	83	80	47	80	350	0.57	58	75	83
Organics* (mg/kg)												
Heptachlor Epoxide	U	U	U	U	4.9	U	U	U	U	U	U	U
Alpha-Chlordane	7.2	U	U	U	U	U	U	U	U	U	U	U
Gamma-Chlordane	6.9	U	4.9	U	U	U	U	U	U	U	U	U
Bis (2-Ethylhexyl) Pthalate	0.2	U	U	U	U	U	U	U	U	U	U	U
Radionuclides (pCi/g)												
Co-60	0.029	0.01	0.018	0.01	0.045	0.01	0.526	0.01	0	0.01	0.01	0.01
Cs-137	0.575	0.415	0.627	0.415	0.371	0.215	0.556	0.215	0.333	0.498	0.459	0.415
U-235	0.123	0.102	0.1	0.102	0.063	0.071	0.156	0.071	0.087	0.033	0.075	0.102
U-238	1.96	1.05	2.18	1.05	1.68	0.725	2.73	0.725	1.55	0.888	1.37	1.05

*Only parameters that had detectable levels were reported

U - Undetected, N/A- Not analyzed

B.3 WEST END TREATMENT FACILITY EFFLUENT CHARACTERISTICS

This section discusses the proposed sanitary sewer discharge limits and characterization of the WETF effluents. Effluent limits and characteristics discussed include constituent inorganic chemicals, heavy metals, organic chemicals, radionuclides, and pathogens as they relate to the sanitary sewer system.

Proposed Sanitary Sewer Discharge Limits

Appendix B, Table B.12 lists sanitary sewer discharge limits for WETF that were proposed in the sanitary sewer assessment (WSMS 2000). These limits are mass-based for each month, meaning the discharges up to total quantity of a specified parameter are allowed and cannot be exceeded. WETF effluent discharges will be controlled using metered pumps at pre-determined rates to ensure that a non-conformance does not occur. The final discharge rate will be determined using critical parameter limits after the treated wastewaters have been sampled and analyzed. Because discharge limits are mass-based, the discharge rate is inversely proportional to the concentration of contaminants. Put simply, the lower the concentration of residual contaminants in the wastewater, the higher the rate of discharge to the sewer system.

Table B.12. Proposed WETF Sanitary Sewer Monthly Discharge Limits

Parameter	Proposed WETF Discharge Mass Limit (g)	Existing Y-12 Plant Discharge Mass Limit (g)
Silver	42.5	85
Arsenic	8.5	17
Cadmium	2.8	5.6
Total Chromium	42.5	85
Copper	119.0	238.1
Iron	8,510	17010
Mercury	19.5	39.1
Nickel	85.1	170.1
Lead	41.7	83.3
Total Kjeldahl Nitrogen	38,300	76545
Total Suspended Solids	170,000	340200
Zinc	297.7	595.3
Cyanide	34.8	69.7
Oil and Grease	21,300	42525
Phenols	255.2	510.3
Benzene	8.5	17
Methylene Chloride	22.9	45.9
Trichloroethane	15.3	30.6
Toluene	8.5	17
Total Uranium*	1260	1200

*Not a limit, acceptance levels discussed with the City of Oak Ridge

Inorganic Chemicals

Inorganic compounds such as nitrates are typically found within WETF wastewater batches and are treated in the bio-denitrification units. These treatment units are 99.9% effective in reducing these residual inorganic compounds to extremely low or non-detectable levels. Excess mass calculations (i.e., remaining contaminant capacities in comparison with established limits, taking into account all dischargers within the Y-12 sewer system) for inorganic compounds in WETF wastewater batches are adequate and should not pose any discharge non-compliances or measurable regulatory impacts within the Y-12 or City of Oak Ridge sanitary sewer systems.

Heavy Metals

A variety of metals are present at varying times and levels within WETF operations. Heavy metals typically found in wastewater batches are cadmium, chromium, arsenic, lead, silver and nickel, among others. Based upon excess mass calculations for the Y-12 sewer system, an adjustment in the current permitted Y-12 nickel limits were discussed with the City of Oak Ridge. A proposed, increased concentration for the Y-12 BWXT IDP from 0.021 mg/l to 0.1 mg/l for nickel would accommodate the addition of the WETF discharges. The proposed limit for each 500,000-gallon WETF wastewater batch is 85 g. It is anticipated that other heavy metal limits (e.g., chromium, lead, etc.) currently in effect will adequately accommodate the WETF discharges into the Y-12 sewer system.

The City of Oak Ridge issues heavy metal limits based upon NPDES discharge criteria and loading limits imposed upon the Oak Ridge Reservation Biosolids Land Application Sites, as established in 40 CFR 503. EPA allows for land application sites to be loaded to 100% of each metal limit but to provide notification when 90% of any limit has been attained. Since WETF wastewater heavy metal levels, with the exception of nickel, can adequately meet Y-12 discharge criteria without a permit modification, only a minimal increase, 0.003% for nickel, in cumulative metal levels on land application sites is expected. 40 CFR 503.13 requires that the city meet biosolids heavy metal ceiling concentrations in Table 1 and land application site cumulative loading limits in Table 2. To date, the highest cumulative metal loading level is 6% which involves mercury at the Rogers Site.

Organic Chemicals

WETF 500,000 gallon wastewater batches that indicate the presence of excess organic compounds from initial characterization data performed after bio-denitrification will undergo treatment in the bio-oxidation units. These treatment units are 99.9% effective in reducing residual organic compounds to very low levels. If necessary, wastewater batches will also undergo carbon adsorption to remove any residual organic compounds to ensure compliance with the Y-12 IDP. Polychlorinated Biphenyls (PCBs) are prohibited at WETF and should not be present in effluent discharges to the Y-12 sewer system. Existing excess mass calculations (i.e., remaining contaminant capacities in comparison with established limits, taking into account all dischargers within the Y-12 sewer system) for organic compounds in WETF wastewater batches are adequate and should not pose any discharge non-compliances or measurable regulatory impacts within the Y-12 or City of Oak Ridge sanitary sewer systems. At the present time, there are no EPA organic compound limits for biosolids or land application site soils. Because organic compounds are removed in the treatment process at WETF, treated wastewaters are not expected to cause toxicity problems within the Y-12 or City of Oak Ridge sewer systems.

Radionuclides

In discussions held with the city during the WETF Sanitary Sewer Assessment, a proposed limit of 3,785 total grams of uranium was proposed for each 500,000 gallon tank. Based upon a 70 day, 3 month discharge period, this would result in a 1,260 g total uranium level per month acceptance level as stated in ***Table B.12***. Approval of this limit is contingent upon the outcome of this EA and the issuance of a FONSI by DOE.

The corresponding WETF uranium discharge limits will be 2 mg/l at 5 gpm or 3,785 total grams of uranium per 500,000-gallon tank. At the proposed discharge rate, a maximum of 1,260 total g of uranium would be discharged per month, requiring about 70 days to discharge the entire tanks contents. This increase in total uranium discharged to the city would result in an increase of 0.04 g/kg for total uranium in city biosolids that are land applied on ORR land application sites (See ***DOE EA-1356, Appendix F***).

DOE Order 5400.5 (DOE, 1993) also lists derived concentration guidelines (DCGs) for specific radionuclides that are discharged in effluents to public utilities and U.S. waterways. This Order requires that all radionuclides are identified and divided by their corresponding DCG limit to produce a "fraction" (e.g., 1 pCi/l / 10 pCi/l limit = 0.1). This fraction is added to other radionuclide fractions that may be present in the effluent and is multiplied by 100. This represents an overall percentage or a "Sum of Fractions" for radionuclides within a given discharge.

The sum of fractions methodology will be used in demonstrating compliance with the Order for WETF discharges. The sum of fractions limit, as listed in the Order, is 5. WETF discharges will not exceed a sum of 5 to ensure compliance with the Order. This will be accomplished using a spreadsheet developed for each WETF discharge. The radionuclides that will be included in the spreadsheet will be evaluated using generator wastewater characterization data prior to treatment at WETF and process sampling to determine appropriate compliance with DOE Order 5400.5.

Radionuclide modeling calculations have been performed that simulate a discharge from WETF at a sum of fractions of 5, combined with low flow rates and maximum radionuclide levels observed to be discharged from the Y-12 sewer system to the City of Oak Ridge from 1994 to 1998. In this worst-case scenario, the total sum of fractions at the point of discharge to the city was approximately 0.2, well below the limit of 5 as listed in the order.

Pathogens

WETF effluents do not contain pathogenic organisms.